Claims

[c1] 1. A method of manufacture comprising the following steps:

forming a preform of acoustic backing material having an array of holes that pass through the preform from one side to the other;

depositing an electrically conducting film onto at least one face of the acoustic backing preform and onto the surfaces of the holes that span the acoustic backing material;

filling the remaining volume inside the holes with acoustic backing material;

mounting the resulting layer of acoustic backing material onto a transducer array; and

electrically separating each transducer element to allow for individual electrical connection.

[c2] 2. A method of manufacturing an ultrasonic transducer comprising the following steps:

forming an array of holes in a relatively thick layer of acoustically attenuative material having front and rear faces, each hole spanning the thickness of said body from said front face to said rear face thereof;

depositing a first relatively thin layer of electrically conductive material on at least said front face of said relatively thick layer and on the surfaces of said holes;

filling the remaining volume of said holes with acoustically attenuative material;

depositing a second relatively thin layer of electrically conductive material on a rear face of a layer of piezoelectric material;

laminating said relatively thick layer of acoustically attenuative material to said layer of piezoelectric material with said first and second relatively thin layers of electrically conductive material electrically connected; and

dicing said layer of piezoelectric material and a portion of said relatively thick layer of acoustically attenuative material along a first plurality of mutually parallel planes to a sufficient depth to form a plurality of kerfs that electrically isolate a plurality of regions of said first and second relatively thin layers from each other.

[c3] 3. The method as recited in claim 2, further comprising the following steps:

depositing a third relatively thin layer of electrically conductive material on a front face of said layer of piezoelectric material;

depositing a fourth relatively thin layer of electrically conductive material on a rear face of a relatively thick layer of acoustic impedance matching material;

mounting said first relatively thick layer of acoustic impedance matching material to said layer of piezoelectric material with said third and fourth relatively thin layers of electrically conductive material in contact with each other; and

dicing said relatively thick layer of acoustic impedance matching material, said layer of piezoelectric material and a portion of said relatively thick layer of acoustically attenuative material along a second plurality of mutually parallel planes to a sufficient depth that a plurality of subregions of each of said electrically isolated regions of said first and second relatively thin layers of electrically conductive material are electrically isolated by a second plurality of kerfs, said second plurality of kerfs being substantially orthogonal to said first plurality of kerfs.

[c4] 4. The method as recited in claim 3, further comprising the step of dicing at least a portion of said relatively thick layer of acoustic impedance matching material along said first plurality of mutually parallel planes to a depth such that said third relatively thin layer of electrically conductive material is not diced.

[c5] 5. The method as recited in claim 2, wherein said array of holes comprises first and second rows of holes, further comprising the steps of attaching first and second printed circuits to said relatively thick layer of acoustically attenuative material with conductive traces of said first printed circuit in contact with said relatively thin layers of electrically conductive material deposited in respective holes of said first row and with conductive traces of said second printed circuit in contact with said relatively thin layers of electrically conductive material deposited in respective holes of said second row.

[c6] 6. The method as recited in claim 2, further comprising the step of dicing said layer of piezoelectric material and said portion of said relatively thick layer of acoustically attenuative material along a second plurality of mutually parallel

planes to a sufficient depth that a plurality of subregions of each of said electrically isolated regions of said first and second relatively thin layers of electrically conductive material are electrically isolated by a second plurality of kerfs, said second plurality of kerfs being substantially orthogonal to said first plurality of kerfs.

[c7] 7. The method as recited in claim 2, wherein the acoustically attenuative material filling said holes and the acoustically attenuative material of said relatively thick layer have substantially the same composition.

[c8] 8. A method of manufacturing an ultrasonic transducer comprising the following steps:

forming a mold having a plurality of columns;

depositing a first relatively thin layer of electrically conductive material on the inner surfaces of said mold, including the peripheral surfaces of said columns;

casting acoustically attenuative material in said mold to form a relatively thick layer of said acoustically attenuative material joined to said first relatively thin layer of electrically conductive material, with an array of holes formed by said plurality of columns;

removing said mold while leaving said first relatively thin layer of electrically conductive material joined to said relatively thick layer of said acoustically attenuative material;

filling the remaining volume of said holes with acoustically attenuative material;

depositing a second relatively thin layer of electrically conductive material on a rear face of a layer of piezoelectric material;

mounting said relatively thick layer of acoustically attenuative material to said layer of piezoelectric material with said first and second relatively thin layers of electrically conductive material in contact with each other; and

dicing said layer of piezoelectric material and a portion of said relatively thick layer of acoustically attenuative material along a first plurality of mutually parallel planes to a sufficient depth that a plurality of regions of said second relatively thin layer on said rear face of said layer of piezoelectric material and a corresponding plurality of regions of said first relatively thin layer on said front face of said relatively thick layer of acoustically attenuative material are

electrically isolated by a first plurality of kerfs.

[c9] 9. The method as recited in claim 8, further comprising the step of dicing said layer of piezoelectric material and said portion of said relatively thick layer of acoustically attenuative material along a second plurality of mutually parallel planes to a sufficient depth that a plurality of subregions of each of said electrically isolated regions of said first and second relatively thin layers of electrically conductive material are electrically isolated by a second plurality of kerfs, said second plurality of kerfs being substantially orthogonal to said first plurality of kerfs.

[c10] 10. The method as recited in claim 8, wherein the acoustically attenuative material filling said holes and the acoustically attenuative material of said relatively thick layer have substantially the same composition.

[c11] 11. An ultrasonic transducer comprising an array of piezoelectric transducer elements and an acoustic backing layer acoustically coupled to the rear face of each of said piezoelectric transducer elements, said acoustic backing layer comprising a layer of acoustically attenuative material with a plurality of via-shaped internal structures, each of said via-shaped internal structures having a deposit of electrically conductive material thereon and bounding a volume filled with acoustically attenuative material.

[c12] 12. The ultrasonic transducer as recited in claim 11, wherein said piezoelectric transducer elements and confronting portions of said acoustic backing layer are isolated by a plurality of spaced kerfs disposed parallel to an elevational plane, each piezoelectric transducer element having an electrode on its rear face and each isolated portion of said acoustic backing layer having a conductive pad on its front face, each conductive pad being in contact with a respective electrode.

[c13]

13. The ultrasonic transducer as recited in claim 11, wherein said piezoelectric transducer elements and confronting portions of said acoustic backing layer are isolated by a grid comprising a first plurality of spaced kerfs disposed parallel to a first elevational plane and a second plurality of spaced kerfs disposed parallel to a second elevational plane substantially orthogonal to said first

elevational plane, each piezoelectric transducer element having an electrode on its rear face and each isolated portion of said acoustic backing layer having a conductive pad on its front face, each conductive pad being in contact with a respective electrode.

[c14] 14. The ultrasonic transducer as recited in claim 11, wherein the acoustically attenuative material filling said bounded volumes and said layer of acoustically attenuative material have substantially the same composition.

[c15] 15. The ultrasonic transducer as recited in claim 11, wherein each of said piezoelectric transducer elements has an electrode on its front face, said transducer further comprising a thin layer of electrically conductive material in contact with said electrodes on said front faces of said piezoelectric transducer elements and electrically connected to ground.

[c16] 16. The ultrasonic transducer as recited in claim 15, further comprising a layer of acoustic impedance matching material, wherein said thin layer of electrically conductive material comprises metallization on a surface of said layer of acoustic impedance matching material.

[c17] 17. An ultrasonic transducer comprising an acoustic backing layer and first and second ultrasonic transducer elements acoustically coupled to said acoustic backing layer and separated from each other by a gap, each of said first and second ultrasonic transducer elements comprising front and rear faces, said rear faces having a deposit of electrically conductive material, and said acoustic backing layer comprising:
a layer of acoustically attenuative material comprising top and bottom surfaces, said top surface of said acoustically attenuative layer confronting said rear faces of said first and second ultrasonic transducer element; and
first and second electrical conductors, each of said first and second electrical conductors comprising a respective conductive pad on a respective region of said front surface of said acoustically attenuative layer and a respective conductive trace that is embedded in a respective volume of said acoustically attenuative layer and extends through a thickness of said acoustically attenuative layer, said conductive pads of said first and second electrical

conductors being separated from each other by a gap that is substantially coplanar with said gap between said first and second ultrasonic transducer elements.

[c18] 18. The ultrasonic transducer as recited in claim 17, wherein each of said conductive pads of said first and second electrical conductors covers a respective ring-shaped area having a polygonal outer periphery and a non-polygonal inner periphery, and each of said conductive traces is via-shaped with one end connected to said inner periphery of said conductive pad and another end that is exposed at said bottom surface of said acoustically attenuative layer.

[c19] 19. The ultrasonic transducer as recited in claim 18, wherein said non-polygonal inner periphery is substantially circular.

[c20] 20. The ultrasonic transducer as recited in claim 18, wherein said polygonal outer periphery is substantially rectangular.

[c21] 21. The ultrasonic transducer as recited in claim 17, further comprising third and fourth electrical conductors respectively connected to said exposed ends of said conductive traces of said first and second electrical conductors, and a substrate made of dielectric material supporting said third and fourth electrical conductors.

[c22] 22. The ultrasonic transducer as recited in claim 21, wherein said substrate is flexible.

[c23] 23. The ultrasonic transducer as recited in claim 21, wherein said front faces of said first and second ultrasonic transducer elements each have a deposit of electrically conductive material, further comprising a fifth electrical conductor connected to said deposits on said front faces of said first and second ultrasonic transducer elements.

[c24] 24. The ultrasonic transducer as recited in claim 23, wherein said fifth electrical conductor is connected to ground and said third and fourth electrical conductors are connected to first and second signal sources respectively.

[c25] 25. The ultrasonic transducer as recited in claim 23, further comprising first and

second acoustic impedance matching elements joined to said fifth electrical conductor, said first and second acoustic impedance matching elements respectively overlying said front faces of said first and second ultrasonic transducer elements.

[c26] 26. An ultrasonic transducer comprising an acoustic backing layer made of acoustically attenuative material, a array of ultrasonic transducer elements that generate ultrasound waves in response to electrical excitation, each ultrasonic transducer element having a rear face acoustically coupled to a respective region of a front face of said acoustic backing layer, a array of acoustic matching layer elements, each ultrasonic transducer element having a front face acoustically coupled to a respective acoustic matching layer element, a common ground connection made of electrically conductive material and disposed between said array of ultrasonic transducer elements and said array of acoustic matching layer elements, and a plurality of electrical conductors that pass through said acoustic backing layer, wherein said front and rear faces of said ultrasonic transducer elements have deposits of electrically conductive material thereon; each of said electrical conductors comprises a respective conductive pad formed on said front face of said acoustic backing layer and in electrical contact with an opposing rear face of a respective ultrasonic transducer element; each of said electrical conductors further comprises a respective conductive trace deposited on a respective via-shaped structure in said acoustic backing layer, connected to a respective one of said conductive pads and exposed at a rear face of said acoustic backing layer; and no part of said common ground connection passes through said acoustic backing material.

[c27] 27. The ultrasonic transducer as recited in claim 26, wherein said array of ultrasonic transducer elements are arranged in a two-dimensional array with each of said ultrasonic transducer elements being substantially electrically and acoustically isolated from neighboring ultrasonic transducer elements, said plurality of conductive pads being arranged in said two-dimensional array with each of said conductive pads substantially electrically isolated from neighboring conductive pads.

[c28] 28. The ultrasonic transducer as recited in claim 26, wherein each of said conductive pads has an outer periphery with a shape congruent to a shape of a respective overlapping one of said ultrasonic transducer elements.